APPENDIX A. Detailed Timing and Flow Figures For VRC Protocol

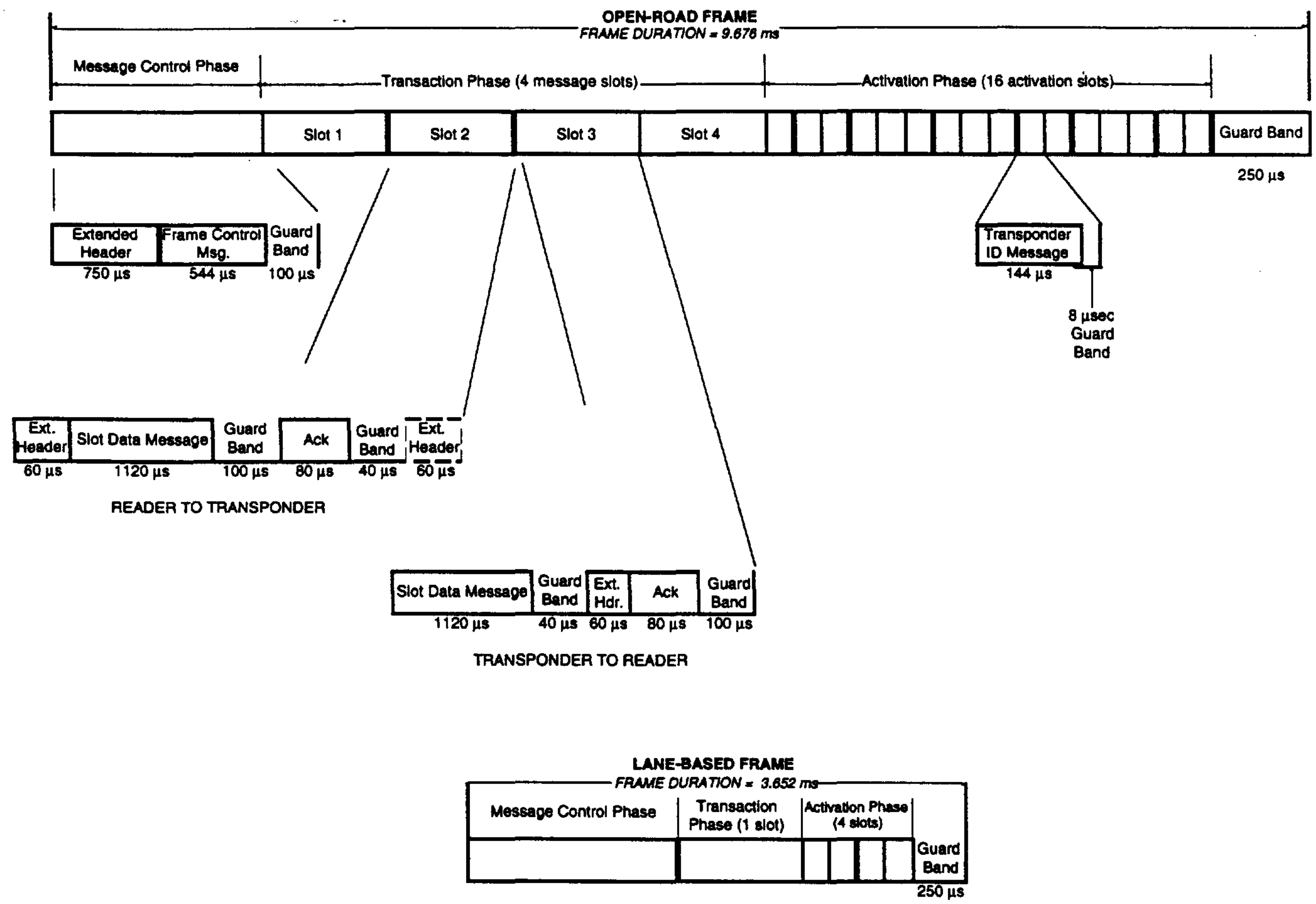

Figure 5-1. Frame Structure and Timing. The detailed slot timing is common to both frame types.

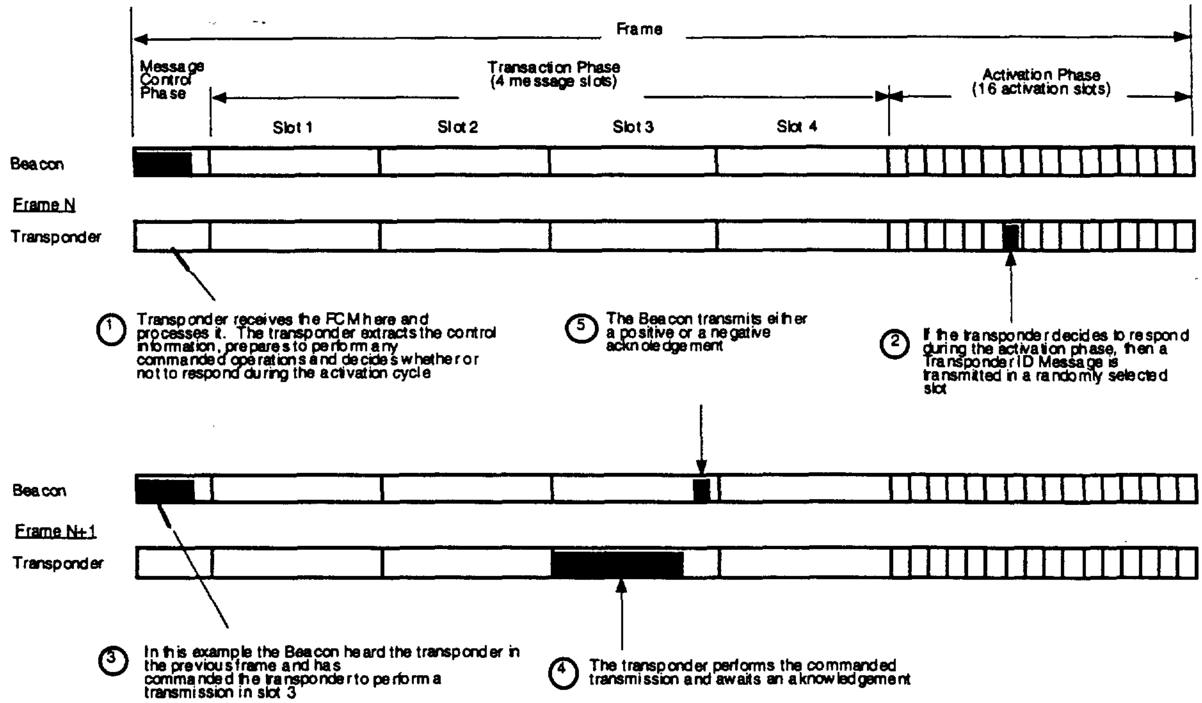

Figure 5-2. Sample Activation and Link Entry Sequence

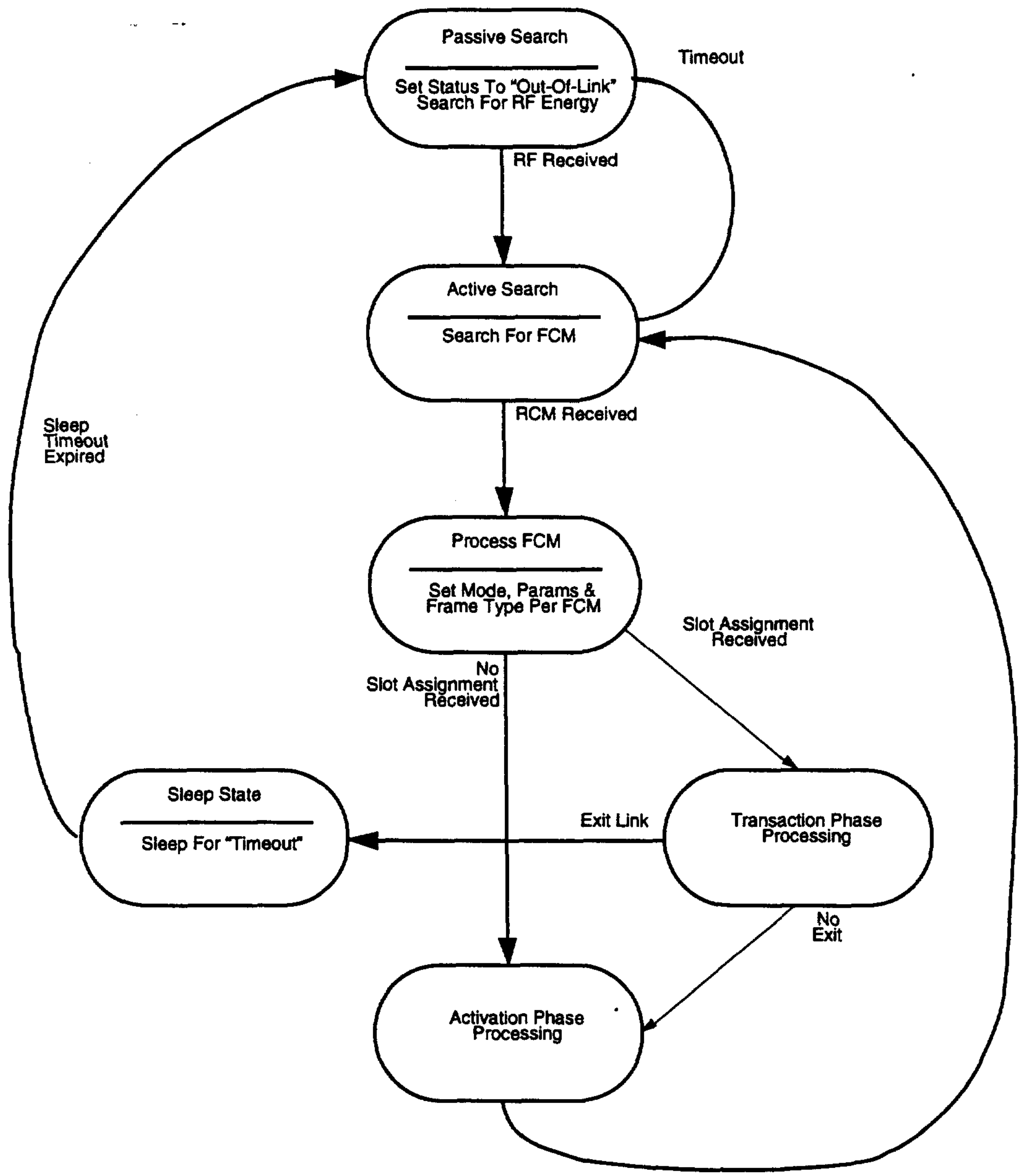

Figure 5-3a. Top Level Protocol Flowchart

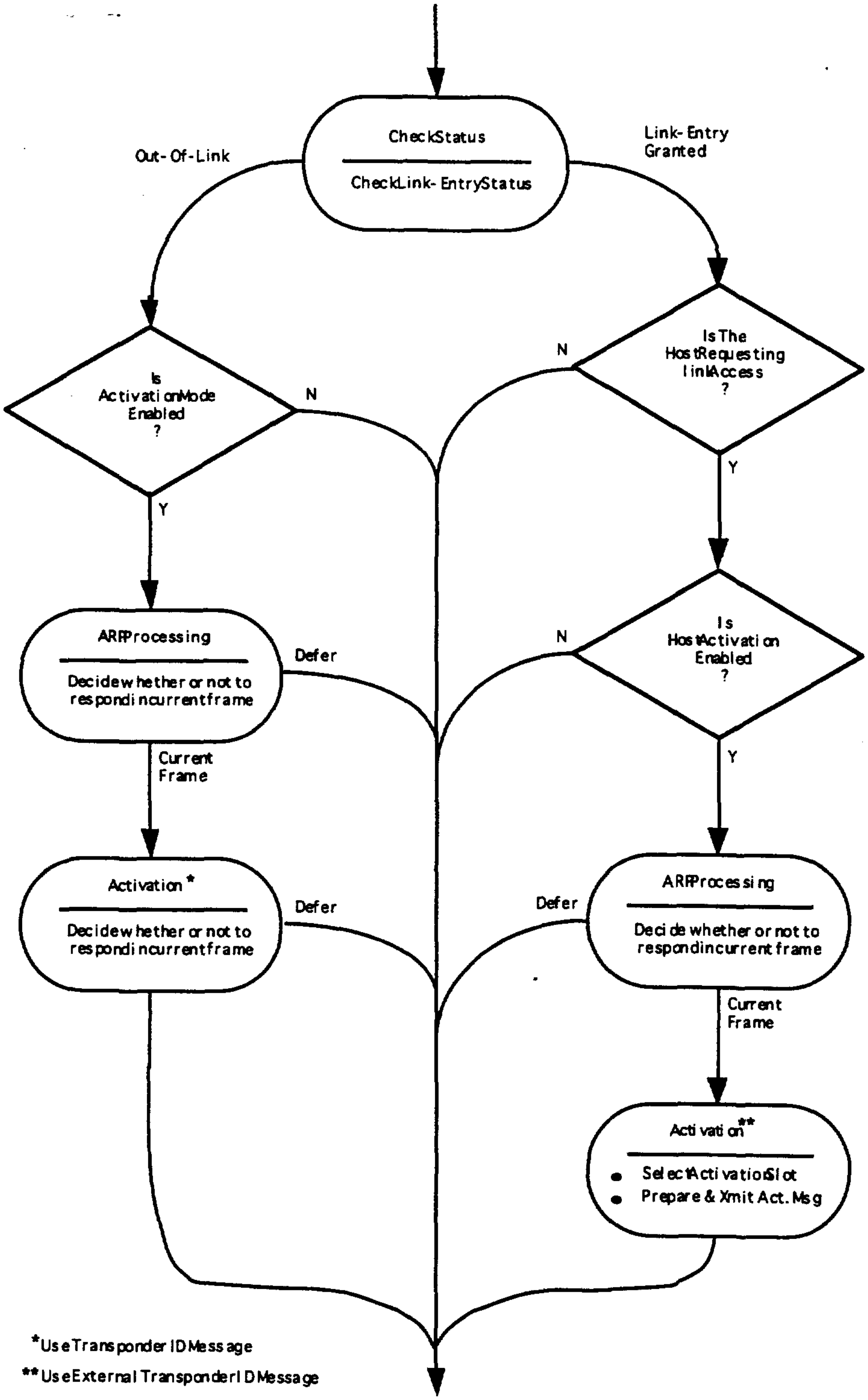

Figure 5-3b. Transponder Activation Phase Processing

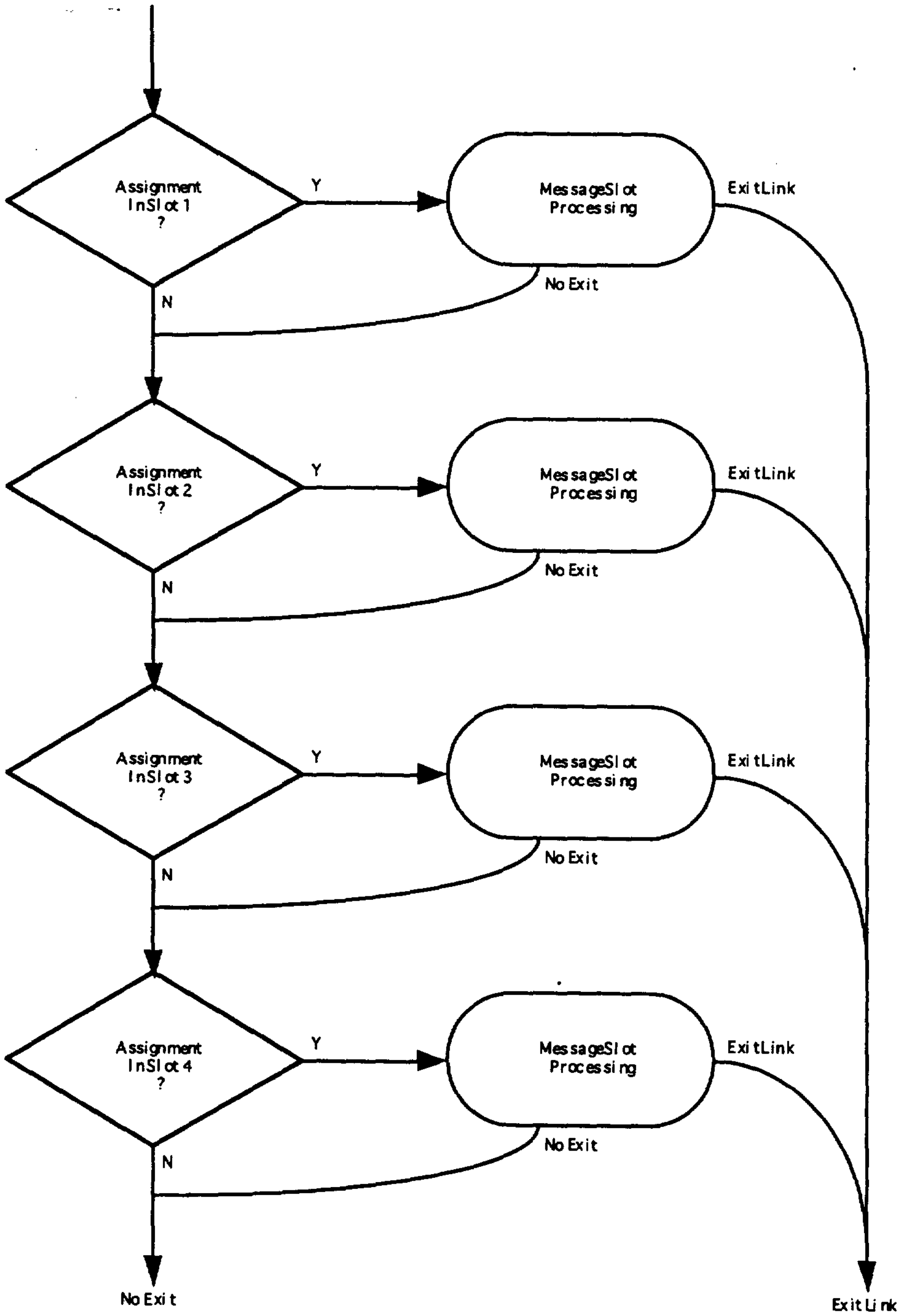

Figure 5-3c. Transaction Phase Processing

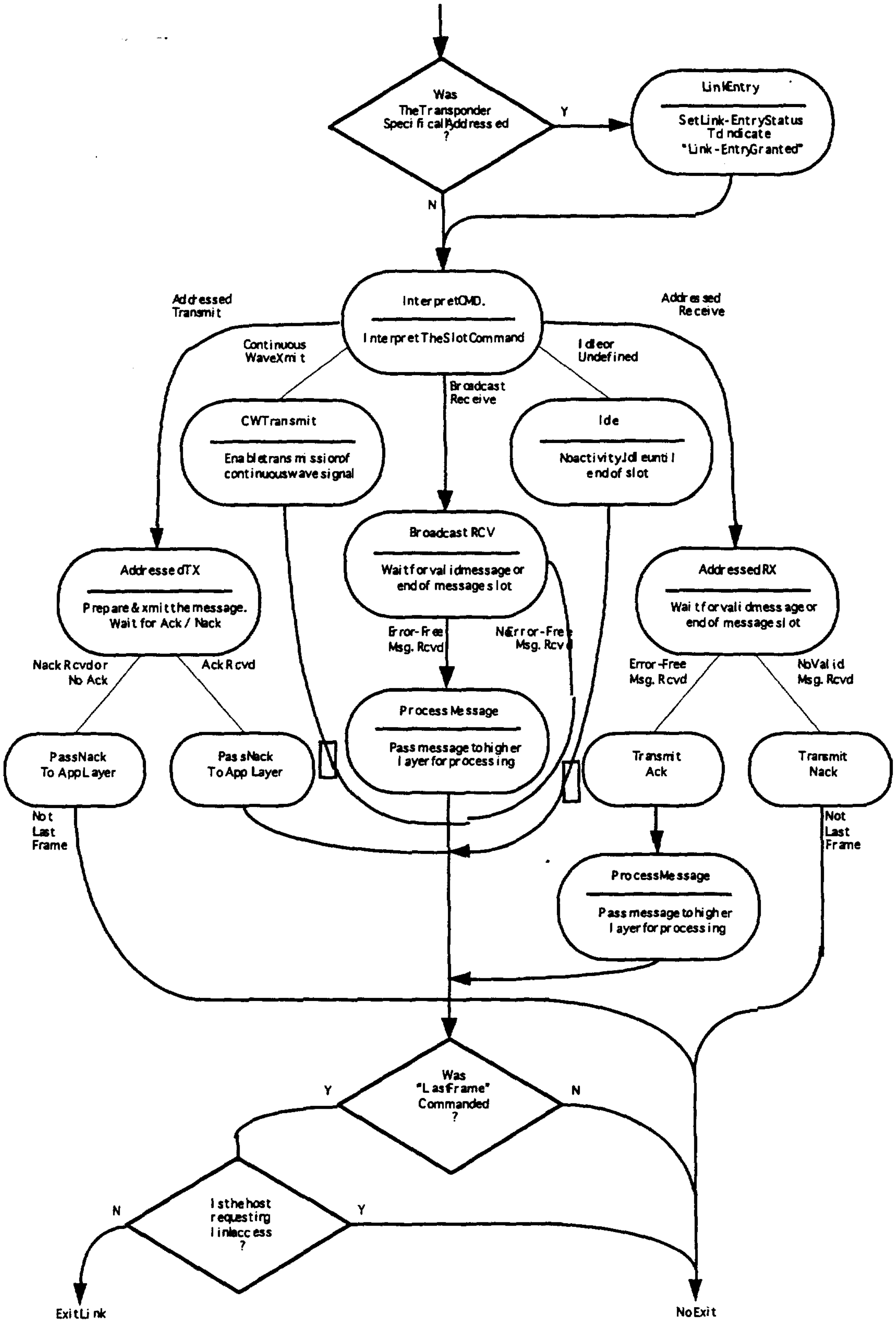

Figure 5-3d. Message Slot Processing

Addendum 1: Radio Frequency Characteristics for U.S. Operation in the 902-928 MHz band

1 FCC Certification

1.1 *U.S. Operation* - The VRC system shall operate in compliance with FCC rules Part 47 CFR 90.353, for licensed operation of dedicated short range vehicle to roadside communications in this frequency band.

2 Reader RF Operating Frequency

2.1 *Center Frequency* - The VRC system shall operate at a nominal frequency of 915 MHz. Frequency accuracy shall meet applicable FCC regulations.

2.2 *Deleted*

3 Transponder RF Characteristics:

3.1 *Transmit Field Strength* - The transmit amplifier and antenna shall operate at a field strength between 175 millivolts/meter to 350 millivolts/meter, when measured at one (1) meter along the antenna boresight.

3.2 *RF Damage Protection* - No permanent damage shall be caused by placing the transponder in a 915 MHz electromagnetic field with a signal strength of 16.5 volts/meter continuous or 50 volts/meter for 30 seconds.

3.3 *Bit Error Rate* - The received bit error rate shall be no greater than 1×10^{-5} when the transponder is placed in a horizontally polarized beacon electric field with a signal strength from 165 mV/meter to 5400 millivolts/meter. A bit error rate of 1×10^{-5} is equivalent to a transaction error rate of 0.8% (no more than 8 misses in 1000 transactions). A successful transaction is defined as a successful FCM reception containing a transponder slot message receive assignment, followed by the successful slot message reception in that same frame.

3.4 *Deleted*

Attachment 3 to Appendix L

EUROPEAN PRESTANDARD, Road Traffic and Transport Telematics (RTTT) - Dedicated Short-range Communication - DSRC Physical Layer using Microwave at 5.8 GHz

EUROPEAN PRESTANDARD

PRENORME EUROPEENNE

EUROPÄISCHE VORNORM

FINAL DRAFT
prENV 12253

December 1995

ICS 35.100.10; 35.240.60

Descriptors : teleprocessing, road transport, traffic, traffic control, data processing, information interchange, data transmission, open systems interconnection, physical layer

English version

Road Traffic and Transport Telematics (RTTT) - Dedicated Short-range Communication (DSRC) - DSRC Physical Layer using Microwave at 5.8 GHz

Télématique de la Circulation et du Transport Routier - Communication dédiée aux courtes portées - ...

Telematik für Straßenverkehr und Transport - Nahbereichskommunikation Bake-Fahrzeug - Physkalische Schicht auf Basis 5,8 GHz Träger

This draft European Prestandard is submitted to CEN members for Formal Vote. It has been drawn up by the Technical Committee CEN/TC 278 .

CEN members shall make the ENV available at national level in an appropriate form promptly and announce its existence in the same way as for EN/HD. Existing conflicting national standards may be kept in force (in parallel to the ENV) until the final decision about the possible conversion of the ENV into an EN is reached.
The lifetime of an ENV is first limited to three years. After two years the Secretary General shall take action by requesting members to send in comments on that ENV within six months. The comments received will be transmitted to the Technical Board for further action as follows:
conversion into an EN after formal vote; or extension of the life of an ENV for another two years (once only); or replacement by a revised ENV approved in accordance with 7.2 and 7.3 of the CEN/CENELEC Internal Regulations Part 2; or withdrawal of the ENV; or assignment to a technical body of the task of assisting the Technical Board to reach any of the decisions listed above.

CEN members are the national standards bodies of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. prENV 12253:1995 E

CONTENTS

Foreword

This European Prestandard has been prepared by The Technical Committee CEN/TC 278 "Road transport and traffic telematics" of which the secretariat is held by NNI.

This document is currently submitted to the Formal Vote.

The subject Pre-Standard forms a part of a series of Pre-Standards defining the framework of a Dedicated Short Range Communication (DSRC) link in the RTTT environment. In addition to this Pre-Standard, the following parts will also be issued by CEN TC278 WG9 to form a complete set of Pre-Standards for the DSRC link.

The complete list of (pre-)standard documents and technical reports, relevant for DSRC:

prENV278/9/#62	**"DSRC Physical Layer using Microwave at 5.8 GHz"**
prENV278/9/#63	"DSRC Physical Layer using Infrared at 850 nm" (*)
prENV278/9/#64	"DSRC Data Link Layer"
prENV278/9/#65	"DSRC Application Layer" (*)

(*) - still under preparation

Further standardisation activities to extend the functionality of DSRC have been initiated on request of TC 278 with the intent to define additional co-existent low data rate channels.

For basic information about RTTT application requirements and the resulting concept for DSRC, please refer the Internal Technical Report 278/9/#61 "DSRC Summary Report", to be published in October 1995.

WG9 consists of experts mainly from telecommunication sector and also from transport sector. Most active participating companies and organisations are:

Austria:	Alcatel, Kapsch
France:	CGA, ISIS, Renault, Thomson, ...
Germany:	Alcatel-SEL, Bosch/ANT, Daimler-Benz Aerospace, RWTH, Siemens, ...
Italy:	Alenia Marconi, Autostrade, UNINFO, ...
Netherlands:	CMG
Norway:	Micro Design
Sweden:	SAAB Combitech Traffic Systems, Telia Research
United Kingdom:	GEC Marconi, Peek plc, STCL

Recommendations and decisions taken by CEPT, ERC, and ETSI have served as references in the preparation of this Pre-Standard (see Section 2 - Normative References and Annex A - Bibliography).

Additional inputs came from non-European experts from USA and Japan via ISO TC204 WG15.

Document Change Control Record (Informative)

registration by CEN TC278	version	date	change description
N 293	-	August 8, 1994	Output document of project team M018/PT06, an very important contribution for standardisation of DSRC Physical Layer (5.8 GHz).
N 387	3.0	February 27, 1995	First presentation of prENV document to CEN TC278
N xxx	4.0	Sept. 25, 1995	Modification of version 3.0 acc. to received comments

INTRODUCTION (Informative)

Dedicated Short-range Communication is intended to be a communication means for Road Traffic and Transport Telematics (RTTT) applications, amongst others such as Automatic Fee Collection (AFC), Automatic Vehicle and Equipment Identification (AVI/AEI) and Traffic and Traveller Information (TTI).

This European Pre-Standard comprises requirements for Open Systems Interconnection (OSI) Layer 1 at 5.8 GHz for DSRC. The Pre-Standard does not include associated measurement procedures for verification of the requirements. Measurement guidelines are intended to be developed in CEN TC278 WG9, together with ETSI RES8, as a separate work item.

The presented requirements distinguish between default and optional parameter values. Procedures for using optional parameters include considerations also of upper OSI Layers. The elaboration of such procedures will be subject to further work within CEN TC278 WG9.

This European Pre-Standard caters for on-board units based on transponder as well as transceiver technologies, and allows for interoperability between systems based on both of these technologies. Furthermore, the Pre-Standard allows for mixed time, frequency and space division multiple access approaches.

This Europen Pre-Standard is conceived for the 10 MHz part, i.e. 5.795 - 5.805 GHz, of the ISM band at 5.8 GHz which is recommended by CEPT. It is recommended to require the exclusive use of this part of the band, considering the probability of interference caused by, or with respect to, other non-DSRC systems. An additional sub-band (5.805 - 5.815 GHz) may be allocated on a national basis for RTTT. To avoid interference impacts, transponder systems based on the backscatter principle, should be equipped with intelligent media-access control.

TITLE(Normative)

a) Road Traffic and Transport Telematics

b) Dedicated Short-Range Communication

c) DSRC Physical Layer using Microwave at 5.8 GHz

1 SCOPE (Normative)

This European Pre-Standard . . .

- establishes a common framework for Physical Layer at 5.8 GHz for DSRC for the RTTT sector.
- provides requirements for the communication medium to be used for exchange of information between road-side units (RSU) and on-board units (OBU).
- does not include associated measurement guidelines for verification of the formulated requirements in this Pre-Standard.
- does not consider any one specific RTTT application, but rather caters for a communication means to be used by several applications in the RTTT sector.

The Physical Layer, at 5.8 GHz, communication requirements for the information from the RSU to the OBU are accounted for as downlink parameters, while the requirements associated with the information from the OBU to the RSU are accounted for as uplink parameters.

Physical Layer 1 requirements related to the interface to other DSRC communication layers are accounted for in 'Interface to Other Layers'.

2 NORMATIVE REFERENCES (Normative)

This European Pre-Standard incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and publications are listed below. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Pre-Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

No.	Source	Title
1	ERC	"ERC Decision of 22 October 1992 on the frequency bands to be designated for the co-ordinated introduction of Road Transport Telematics Systems"; ERC / DEC (92)02.
2	ETSI	ETSI draft standard prI-ETS 300 XXX "Technical characteristics and test methods for data transmission equipment operating in the 5,8 GHz ISM Band"; DI/RES 08-0105:1995, February 1995 (Rev 5)

2.1 Normative Relationship with other Standards

Certain parameters in this European Pre-Standard are set by mutual agreement between ETSI and CEN. The relevant standards are prI-ETS 300 xxx and prENV278/9/#62. These parameters are identical in each standard and cannot be changed by either ETSI or CEN without the simultaneous agreement of each organisation.

3 DEFINITIONS, SYMBOLS AND ABBREVIATIONS (Normative)

3.1 Definitions for Downlink Parameters

Downlink parameters apply to transmission of data from RSU to OBU. For the purpose of this standard, the following definitions apply:

D 1 Carrier Frequencies

Number and values of the downlink carrier frequencies which are equal to the frequencies of the CW transmitted by the RSU and used by transponder OBUs for uplink communication. Each carrier frequency is the center frequency of a downlink band.

D 1a Tolerance of Carrier Frequencies

Maximum deviation of the carrier frequency caused by any impact. It is expressed in parts per million (ppm).

Example: 1 ppm of a 5.8 GHz carrier allows for the carrier frequency to be in the range of 5.8 GHz ± 5.8 kHz.

D 2 RSU Transmitter Spectrum Mask

Maximum power (density) emitted by the RSU transmitter as function of the frequency .

D 3 OBU Minimum Receiver Bandwidth

Minimum range of frequencies which has to be received by the OBU receiver.

D 4 Maximum E.I.R.P.

The maximum peak envelope power transmitted by the RSU referred to an isotropic antenna. The value is normally expressed in dBm. 0 dBm equals 1 mW.

D 4a Angular E.I.R.P. mask

Maximum E.I.R.P. as a function of the angle Θ, where Θ indicates the angle relative to a vector perpendicular to the road surface, pointing downwards

D 5 Antenna Polarization

Locus of the tip of the vector of the electrical field strength in a plane perpendicular to the transmission vector. Examples are horizontal and vertical linear polarization and left and right hand circular polarization.

D 5a Cross Polarization

Ellipticity of an antenna.

Example: If an antenna is designed to be a left hand circular antenna and it may receive (transmit) as well right hand circular waves this is a mismatch. Cross Polar Discrimination (XPD) is measured as the ratio P_{LHC}/P_{RHC} of the power of the correct polarized wave P_{LHC} and of the wrong polarized wave P_{RHC}.

D 6 Modulation

Keying of the carrier wave by coded data. Some examples are Amplitude Shift Keying (ASK), Phase Shift Keying (PSK) and Frequency Shift Keying (FSK) and linear amplitude modulation (AM).

D 6a Modulation Index

Size of the variation of the modulation parameter (frequency, amplitude, phase) caused by the modulation signal (data signal).

D 6b Eye Pattern

Free decision distance in width and height of a digital signal. An ideal digital signal has a decision height of 100 % which is equal to the difference of high level and low level. Considering e.g. bi-phase coding, the ideal (=100%) distance in width is equal to half the bit duration.

D 7 Data Coding

Baseband signal presentation, i. e. a mapping of logical bits to physical signals. Examples are bi-phase schemes (Manchester, FM0, FM1, differential Manchester), NRZ and NRZI.

D 8 Bit Rate

Number of bits per second, independent of the data coding.

D 8a Tolerance of Bit Clock

Max. deviation of the bit clock caused by any impact, expressed in ppm or in %.

Example: 100 ppm of 500 kBit/s allows for the bit clock to be in the range of 500 kHz ± 50 Hz

D 9 Bit Error Rate (B.E.R.)

Averaged number of erroneous bits related to all transmitted bits. Used only as a reference value for layer 1. The realized B.E.R. depends on the application, and does not consider any specific distribution of errors. The effective B.E.R. within the communication zone may be different to the reference value due to time variant and stochastical impacts.

D 10 Wake-up Process for OBU

Process within the OBU which ...

(1) indicates to the OBU that it is within a communication zone, i.e. that it may now communicate with a RSU;

(2) switches the OBU main circuitry from stand by mode (sleep mode) to the active mode.

This is a feature to allow the OBU to save battery power. It is not mandatory for an OBU to use a wake-up process.

D 10a Maximum Start Time

Maximum time between the reception within the communication zone of a down-link message of minimum length, and the time when the OBU has switched to the active mode and is ready for operation.

D 11 Power Limits within Communication Zone

Minimum and maximum values of incident power referred to a 0 dB antenna in front of OBU and referred to the outside of the vehicle. These two values also specify the dynamic range of the OBU receiver. Power values are measured without any additional losses due to rain or misalignment.

D 13 Preamble

Specific Layer 1 address, independent of Layer 2. It is either only an unmodulated carrier wave or a modulated carrier, in which case the requirement refers to the channel after coding.

D 13a Preamble Length

Length of the preamble measured in number of bits.

D 13b Preamble Waveform

Signal shape of the preamble as it is on the channel.

3.2 Definitions for Uplink Parameters

Uplink parameters apply to transmission of data from OBU to RSU. For the purpose of this standard, the following definitions apply:

U 1 Sub-carrier Frequencies

Number and values of the uplink sub-carrier frequencies, i.e. the frequency distance of the center of the uplink band to the corresponding downlink carrier, i.e. to the center of the corresponding downlink band.

U 1a Tolerance of Sub-carrier Frequencies

Maximum deviation of the sub-carrier frequency caused by any impact. Normally it is expressed in % or in parts per million (ppm) of the sub-carrier frequency.

Example: 1 % of 1.5 MHz sub-carrier allows for the sub-carrier frequency to be in the range of 1.5 MHz ± 15 kHz.

U 1b Use of Side Bands

Specification of the use of the uplink sidebands. Data can be modulated on only the upper side band or on both side bands. As an option, different data can be modulated on the two side band.

U 1c Tolerance of Direct Generated Uplink Carrier

Maximum relative deviation of the uplink carrier in case it is generated directly within a (transceiver type) OBU. Refer to U1a and D1a.

U 2 OBU Transmitter Spectrum Mask

Maximum power (density) as function of the frequency emitted by the OBU transmitter.

U 3 RSU Minimum Receiver RF Bandwidth

Minimum range of frequencies which has to be received by the RSU receiver.

U 4 Maximum Single Sideband E.I.R.P.

Maximum E.I.R.P. transmitted by the OBU outside the vehicle within a single sideband, measured at the maximum incident power within the communication zone. The value is normally expressed in dBm. 0 dBm equals 1 mW. All power values are referred to an isotropic antenna.

U 5 Antenna Polarization Refer to D 5

U 5a Cross Polarization Refer to D 5a

U 6 Sub-Carrier Modulation

Keying of the sub-carrier wave by coded data. Some examples are Amplitude Shift Keying (ASK), Phase Shift Keying (PSK), and Frequency Shift Keying (FSK).

U 6a Data Modulation Order

Number (M) of different amplitude levels for ASK, the number of phase states for PSK and the number of frequencies for FSK. Normally the carrier is modulated by digital symbols. Each symbol represents a combination of k bits which allow to represent $M=2^k$ different states. The modulation order is equal to this number M.

U 6b Eye Pattern / Duty Cycle

For the definition of eye pattern, refer to D6b. Duty cycle: The ratio of the length of high or low pulses to the duration of a complete cycle.

U 6c Modulation on Carrier

Keying of the carrier wave by the modulated sub-carrier.

U 6d Side Band Suppression

Level of suppression of the unused side band relative to the used side band.

U 6e Side Band Isolation

Minimum suppression of the side band modulated with data stream 1 relative to the side band modulated with data stream 2.

U 7 Data Coding Refer to D 7

U 8 Symbol Rate

Number of symbols per second. This is independent of the data coding. The corresponding bit rate is larger by a factor of ld(M), where ld() is the logarithm to base 2.

Unit used: 1 baud = 1 symbol/s

U 8a Tolerance of Symbol Clock Refer to D 8a

U 9 Bit Error Rate Refer to D 9

U 11 Power Limits within Communication Zone.

CW Power produced by the RSU which allows the reference OBU defined by U12 to have a transmit power E.I.R.P. of a sufficient level to allow the RSU to receive with a B.E.R. not exceeding reference value defined by U9. This parameter is not directly measured.

U 12 Minimum Conversion Gain

Difference between OBU E.I.R.P. within one side band and carrier power incident on OBU. Power is measured outside the vehicle. Measured at the minimum incident power within the communication zone.

Remark: Minimum Conversion Gain is equal to two times the OBU antenna gain minus the OBU losses minus two times the windscreen losses. Windscreen losses depend on the material of the windscreen and on the installation geometry.

U 13 Preamble / Postamble Refer to D 13

U 13a Preamble Length and Pattern

The Preamble Length is measured either in multiples of symbols or in seconds. The Preamble Pattern is a detailed specification of the shape of the preamble signal as it is on the channel after coding.

U 13b Postamble Length and Pattern

The Postamble Length is measured either in multiples of symbols or in seconds. The Postamble Pattern is a detailed specification of the shape of the preamble signal as it is on the channel after coding.

3.3 Definition for Interface Parameters to DSRC Data Link Layer

Parameters defined in this subsection apply to the interface between Layer 1 and 2 of the DSRC link.

D/U14 Link Turn Around Time

The time requested by Layer 1 to process a frame minus the time defined by the symbol / bit rate and the frame length as prepared by Layer 2. This maximum time is important for the higher layers. If time is given in multiples of the bit / symbol duration the appropriate bit / symbol rate has to be chosen, i.e. D8 for D14a/b and U8 for U14a/b. Four different values are defined below.

D14a $RLTA_{rt}$: RSU Link Turn Around from receive mode to transmit mode

The time necessary at the RSU to switch from receive mode to transmit mode.

D14b $OLTA_{tr}$: OBU Link Turn Around from transmit mode to receive mode

The time necessary at the OBU to switch from transmit mode to receive mode.

U14a $OLTA_{rt}$: OBU Link Turn Around from receive mode to transmit mode

The time necessary at the OBU to switch from receive mode to transmit mode.

U14b $RLTA_{tr}$: RSU Link Turn Around from transmit mode to receive mode

The time necessary at the RSU to switch from transmit mode to receive mode.

D22 Minimum Frame Length for OBU Wake-Up.

Minimum length of a frame, including header, necessary to wake up the OBU.

D22a OBU Time-Out

Minimum time OBU must stay in wakeup state without receiving data.

3.4 Symbols

$M=2^k$	Number of symbols
k	Number of bits per symbol
P	Power

3.5 Abbreviations

AM	Amplitude Modulation
ASK	Amplitude Shift Keying
B.E.R.	Bit Error Rate
CW	Continuous Wave
DSRC	Dedicated Short-Range Communication
E.I.R.P.	Equivalent Isotropic Radiation Power
ERC	European Radiocommunications Committee
ETSI	European Telecommunications Standards Institute
FDMA	Frequency Division Multiple Access
FM0 / FM1	Bi-phase coding scheme, bit inverse to FM1 / FM0
FSK	Frequency Shift Keying
NRZ	Non Return to Zero
NRZI	Differential version of NRZ
OBU	On-board Unit, often referred to as transponder
OSI	Open Systems Interconnection
ppm	Parts per million (= 10^{-6})
PSK	Phase Shift Keying
RF	Radio Frequency
RSU	Road Side Unit
SDMA	Space Division Multiple Access
TDMA	Time Division Multiple Access
XPD	Cross Polar Discrimination. Ellipticity of Polarization.

4 REQUIREMENTS (Normative)

4.1 Downlink Parameters

Table 1 below defines the relevant downlink OSI Layer 1 parameters. Initialisation of any communication shall be performed by using the given default values. On-line negotiations, performed by higher DSRC communication layers, may result in utilisation of options values.

The parameters which have been marked with an asterisk (*) are subject to legal type approval requirements. These parameters are specified in ETSI standard prI-ETS 300 XXX. Equipment meeting the requirements of the ETSI standard shall simultaneously satisfy the comparable requirements of this CEN standard. Therefore these parameters have the same value in each standard.

The parameters marked with an asterisk (*) have been set by mutual agreement between ETSI and CEN to achieve efficient use of the radio spectrum and acceptable performance for a short-range communication link, together with other performance requirements set out in this CEN standard. These parameters cannot be changed by either ETSI or CEN without the simultaneous agreement of each organisation.

Table 1: Downlink parameters

Item no.	Parameter	Values: Default	Options
D 1 (*)	Carrier Frequencies	Two downlink channels at: (center frequency) ± Δf. Center frequency of allocated CEPT band: 5.8 GHz Δf = 2.5 MHz	Defined by installation (and due to negotiations): Other 10 MHz band within the same ISM band allocated for RTT on a national basis. Needs one bit for coding. 0 European band 1 National band Management not defined by Layer 1.
D 1a (*)	Tolerance of Carrier Frequencies	within ± 5 ppm	-

D 2 (*)	RSU Transmitter Spectrum Mask	(1) Out band power: ≤ -30 dBm (2) In band power: ≤ +33 dBm (3) Spurious emission for unmodulated carrier wave shall be less than: Co-channel uplink @ 1.5 MHz: ≤ - 27 dBm in 500 kHz. Co-channel uplink @ 2.0 MHz: ≤ - 27 dBm in 500 kHz. Adjacent channel uplinks: ≤ - 47 dBm in 500 kHz. (4) For in band spurious emission with modulated carrier wave, three different requirement classes are defined: ***Class A:*** Co-channel uplink @ 1.5 MHz: ≤ -7 dBm in 500 kHz. Co-channel uplink @ 2.0 MHz: ≤ -27 dBm in 500 kHz. Adjacent channel uplinks: ≤ -30 dBm in 500 kHz. ***Class B:*** Co-channel uplink @ 1.5 MHz: ≤ -17 dBm in 500 kHz. Co-channel uplink @ 2.0 MHz: ≤ -27 dBm in 500 kHz. Adjacent channel uplinks: ≤ -37 dBm in 500 kHz. ***Class C:*** Co-channel uplink @ 1.5 MHz: ≤ -27 dBm in 500 kHz. Co-channel uplink @ 2.0 MHz: ≤ -27 dBm in 500 kHz. Adjacent channel uplinks: ≤ -47 dBm in 500 kHz. (Equipment complying with the different classes will require different re-use distance as described in Annex B)	-

D 3	OBU Minimum Receiver Bandwidth	At least CEPT band 5.8 GHz ± 5 MHz	National band within same ISM band
D 4 (*)	Maximum E.I.R.P.	≤ +33 dBm	-
D 4a	Angular E.I.R.P. mask	$\Theta \leq 70^o$: ≤ +33 dBm $\Theta > 70^o$: ≤ +18 dBm	-
D 5 (*)	Antenna Polarization	Left hand circular	-
D 5a	Cross Polarization	XPD: In boresight: $RSU_t \geq 15$ dB $OBU_r \geq 10$ dB At -3 dB area: $RSU_t \geq 10$ dB $OBU_r \geq 6$ dB	-
D 6 (*)	Modulation	Two level amplitude modulation.	-
D 6a (*)	Modulation Index	0.5 ... 0.9	-
D 6b (*)	Eye Pattern	≥ 90 % (time) / ≥ 85 % (amplitude)	-
D 7 (*)	Data Coding	FM0 "1" bit has transitions at the beginning and end of the bit. "0" bit has an additional transition in the middle of the bit compared to the "1" bit.	Defined by installation (and due to negotiations): NRZI. Management not defined by Layer 1 Code: 0 FM0 1 NRZI
D 8 (*)	Bit rate	500 kBit/s	Defined by installation (and due to negotiations): Coded in 3 bit: 000 res. for future use 001 31.25 kBit/s 010 62,5 kBit/s 011 125 kBit/s 100 250 kBit/s 101 500 kBit/s 110 1000 kBit/s 111 res. for future use (Every bit rate has to comply with D2)
D 8a	Tolerance of Bit Clock	better than 100 ppm	-